WATER MANAGEMENT & TREATMENT PLAN

JORGENSEN FORGE EARLY ACTION AREA

Jorgensen Forge Corporation Property
Seattle, WA

Prepared for:

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1.0 Purpose & Objective

The purpose and objective of the Water Management and Treatment Plan is to describe the means and methods that will be implemented to capture, treat, and discharge water generated by upland and in-water activities during the construction of the Jorgensen Forge Early Action Area cleanup.

2.0 Dredge Water Treatment System Design

2.1 Dredge Water Volumes

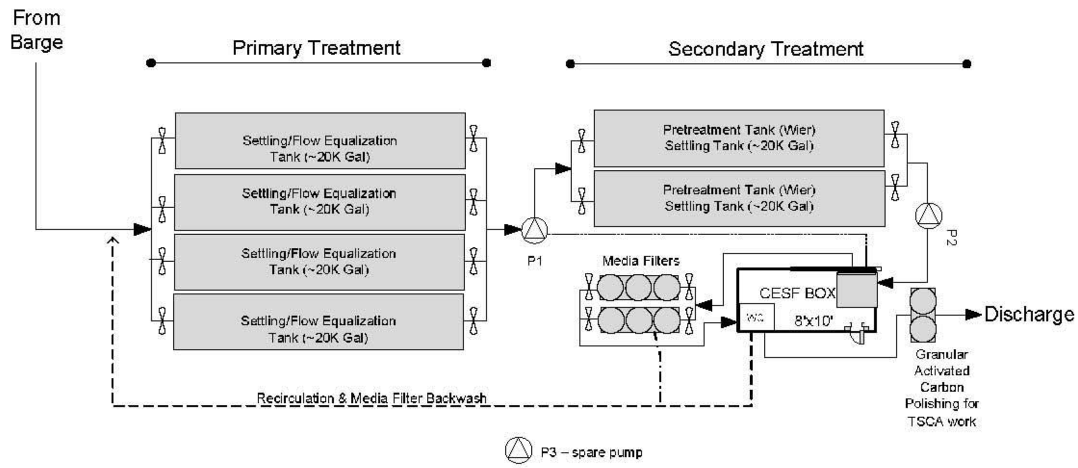
Dredging will occur with an environmental closed bucket (unless the encountered material requires the use of a digging bucket as approved by the Owner's Project

Estimated Dredge Sediment	Cubic Yards	Cubic Feet	Gallons of Water
Total	12,500	337,500	2,534,500
Per Shift	500	13,500	100,098
Per Hour	50	1,350	10,098
Per Minute (average)			168
Anticipated Daily Volume	100,000 – 200,000 gallons		

Engineer), which typically means that roughly equal parts water and sediment are captured in the bucket and transferred to the haul barge. The calculations above are based on this assumption. The average water treatment flow rate from the spoils barge is expected to be around 250 gpm, with a minimum of 150 gpm. The water treatment system is hydraulically sized for a maximum of 500 gpm. The treatment rate will largely depend on the rate of transfer from the spoils barge and frequency of off-loading. Based on dredge return water treatment operations performed on other projects in the area, a settling time of 45 minutes is anticipated to result in settling of a large fraction of solids. A separate catch area on the spoils barge will be created to facilitate settling, resulting in reduced operational costs (tank clean-out, chitosan usage, etc.)

2.2 Dredge Water CESF Treatment Train

The following section discusses the detail of each portion of the chitosan enhanced sand filtration (CESF) system. The primary and secondary treatment components are shown on the conceptual layout drawing.



2.2.1 Primary Treatment (Detention Tanks)

Water from the spoils barge will be pumped to a water treatment system staged on the water treatment barge. The water will first be conveyed into the Primary treatment detention tanks located at the beginning of the treatment train. These tanks will be plumbed in parallel via a header system equipped with valves so that each tank can be isolated if necessary. Isolating tanks will be important during sediment removal and will allow treatment to continue during maintenance activities. Chitosan is only effective in the pH range of 6.0 to 8.5 standard units (SU). Concrete pouring activities, concrete demolition and use of recycled concrete can cause an increase in pH upwards of 10 to 11 SU. Because there is no concrete associated with the dredge activities pH adjustment is not likely needed. However the treatment train is equipped to read and record pH as water enters the system. This injection system is connected to a SC200 Hach controller unit that continuously reads and adjusts the carbon dioxide based on pH readings collected by the pH probe. If the pH is greater than 8.0 SU, liquid carbon dioxide (CO2) will be injected as the water is pumped to the temporary detention tanks.

2.2.2 Secondary Treatment (Chitosan Enhanced Sand Filtration)

As water is pumped from the Primary treatment detention tanks to the Secondary treatment clarification tanks, pretreatment will occur if the incoming turbidity is greater than 400 nephelometric turbidity units (ntu). Pre-treatment injection occurs inline prior to the secondary detention tanks, allowing for reaction and settling within the tanks. The over-under weir pattern in the tanks promotes the settling of large particles whether pretreatment is implemented or not. Water is then pumped from the secondary tanks to the CESF box where the final predetermined amount of chitosan is injected inline based on inline turbidity readings. The amount of chitosan needed is determined at the time of system start-up based on influent turbidity and flow rate. Post chitosan injection, the water travels a minimum of 50’ in a closed line to enhance coagulation prior to filtration. The goal of the chitosan is to coagulate particles smaller than 15 microns into particles larger than 20 micron, which can then be removed with the downgradient sand filter.

Chitosan Acetate

The Chitosan Acetate product for this application will be StormKlear Liqui-Floc™ 1% Solution. The material safety data sheet (MSDS) Sheet StormKlear Liqui-Floc™ 1% solution is attached. The Department of Ecology (Ecology) has granted StormKlear Liqui-Floc™ 1% solution a General Use Level Designation (GULD) for removal of turbidity. Appendix A contains the GULD and StormKlear Liqui-Floc™ 1% MSDS.

2.2.3 Sand Filtration

After chitosan injection and mixing in the pipe, the water enters the sand filter for final polishing. The sand filter is responsible for removing the larger and now filterable coagulated soil particles. The sand filter operates on a pressure differential, which will activate a backwash cycle based on a preset value if the differential becomes too high. Backwash will be sent back to the Primary treatment detention tanks for settling and retreatment through the entire treatment train. Two sand filter banks will be utilized in the treatment train. These will be plumbed in parallel, so that if one filter needs maintenance the other can be quickly brought online.

2.2.4 Water Quality Monitoring Valve

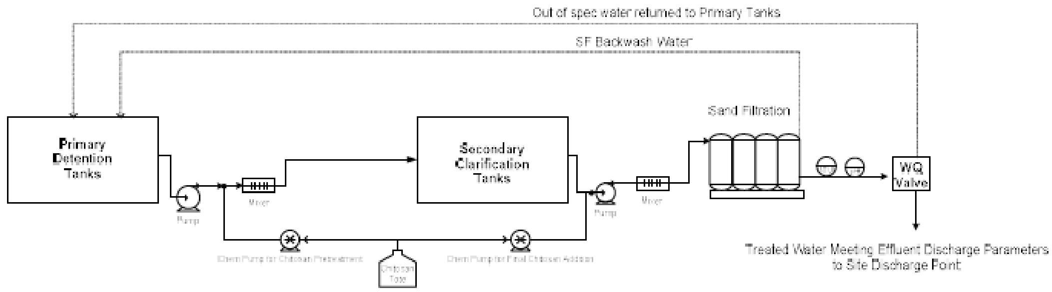
After sand filtration, the turbidity and pH are measured in the treated effluent. Water that is within the permit required set points will then be discharged to the construction work area within the Lower Duwamish Waterway (LDW) or sent to the carbon filters for additional treatment if the dredge water was in contact with sediments/soils containing concentrations of polychlorinated biphenyls (PCBs) greater than the Toxic Substances Control Act (TSCA) threshold (50 parts per million).

If turbidity and/or pH are not within tolerances, the water will be directed back to the Primary treatment tanks for retreatment through the entire treatment train. The Water Quality Monitoring Valve prevents off-spec discharges and prevents blinding and costly replacement of carbon filter media. Due to the volumes treated it is not anticipated that additional carbon filter media will be needed. However WaterTectonics maintains a supply of the media and can have it delivered within the same day if it is determined that it’s needed.

2.2.5 Carbon Filtration

If the dredge water was in contact with sediments/soils containing concentrations of PCBs greater than the TSCA threshold , it will pass through two 2000-pound capacity Granular Activated Carbon (GAC) filters for final polishing. The carbon filters are responsible for further removal of PCBs and other dissolved organic compounds. It is assumed based on the performance of other projects in the area that organics in the dewater fluids will be largely associated with soil or sediment particles and removed during the CESF portion of the treatment train.

2.2.6 Dredge Water Treatment Process Flow Diagram



2.3 Physical Security & Safety

To prevent against theft and vandalism the system pump, chitosan injection pumps, chitosan tote, probes and system controllers will be located in a lockable shipping container on the floating platform. The CESF Box is constructed with an emergency power disconnect. The StormKlear Liqui-Floc™ 1% Chitosan liquid is stored in a double walled tote within the CESF Box. The tote and injection pumps are located over a secondary containment spill pad.

2.4 System Operations

An Operation & Maintenance (O&M) Manual will be located in the CESF Box. As required in the GULD, the system will be operated by certified operators who have completed the 40-hour operator training course approved by Ecology. A brief description of start-up and operational activities is included below. More detailed information can be found in the O&M Manual in Appendix B.

2.4.1 Visual Inspection at Start-Up

1. Visually inspect hydraulic fittings for damage or leakage note observations; replace if needed.
2. Visually inspect the service-entrance-disconnect on the exterior of the operations shed for damage.
3. Visually observe all exterior (influent/effluent) piping for damage or leakage.
4. Visually inspect control panels for dents, scratches, or other damage.
5. Visually inspect the StormKlear™ Liqui-Floc™ bulk storage container for damage. If damage or leakage is observed, photograph the leakage, place an acid absorbent pad under the area of the leak and notify the project manager immediately.
6. Visually inspect the water quality meters or controllers (pH and turbidity).
7. Visually inspect metering pump(s) and connections for leaks.

8. Ensure all electric power cords are plugged in as necessary.

2.4.2 Operations Procedure

1. Open all influent and effluent isolation valves (recirculation/discharge). Be certain that valves are manually in the open position to re-circulate water back to detention/source during startup.
2. Turn on main power to the exterior of the operations shed.
3. Calibrate all monitoring probes or meters according to manufacturer's specifications.
4. Turn on influent pump and adjust valve to desired flow rate (noted on flow meter). System may require a significant time to fill pipes, valves and sandfilter pods before flow rates are accurate.
5. Set sand filter to desired backwash intervals. Set pressure differential to a maximum of 10-15 pounds per square inch. This will allow the sandfilter to automatically backwash at pre-set psi differential should backwash set time intervals not be sufficient to clean the filter beds. Refer to sandfilter manufacturer manual for details.
6. Calibrate StormKlear™ Liqui-Floc™ injection pump(s) using calibration tube to ensure the proper dose is being delivered based on flow rates.
7. Record influent and effluent pH and turbidity readings.
8. Inspect discharge at discharge pipe (in this case recirculation pipe) and measure pH and turbidity levels manually using grab sample and measure against system probe readings to ensure accuracy.
9. Visually inspect StormKlear™ Liqui-Floc™ injection hoses to ensure proper injection.
10. Ensure effluent and recirculation water is within permit or specification numerical criteria using field instrumentation calibrated according to manufacturer's specifications using grab samples and cross checking against system probe readings. Make note of any variations outside of specified limits and do not discharge to LDW until acceptable limits are achieved.
11. When all equipment calibration and system operational inspections are completed return valves to standard positions that will allow discharge to the discharge pipe.
12. Record all information in Daily Log sheet.
13. Perform Residual Chitosan Test within 30 minutes of the onset of discharge. Record results in logbook.

Troubleshooting

Critical equipment are the pumps and sand filter. A spare pump will be kept on the barge, along with a second (spare) sand filter. The spare sand filter will be plumbed during mobilization so that it can be implemented with a change of valving. The lead time for replacement parts should be no longer than 24 hours as most of the small parts are available in WaterTectonics' inventory and when this is the case can be brought from Everett to the site in the same day. WaterTectonics also has a long standing relationship with their large equipment vendor (tanks/sand filters pumps) so that if additional equipment/replacement is necessary it will be a quick turn.

The operators are trained according to Ecology's approved certification course. Operators are walked through simulated failures and have to perform troubleshooting exercises. If WT is not actively operating the systems their experienced operations leads will be available to answer any questions that may arise. In Appendix D is an example escalation chart that shows how issues will be escalated and response times. WT is also a premiere vendor of the Halosource StormKlear Chitosan product and has the full support of the chitosan manufacture's knowledge and expertise. Halosource also produces a biopolymer LBP2101 and a Poly Acrylamide that have been approved by the Dept. of Ecology for use as a pretreatment to Chitosan should additional treatment be necessary. WaterTectonics does not foresee additional treatment measures being necessary but they could be implemented quickly (<24 hours) if necessary. Specific procedures for jar testing, residual chitosan testing, documenting and troubleshooting are located in Appendix D.

Documentation

System operations will be documented in field data sheets kept in a binder in the CESF Box. Example operational data sheets are located in Appendix C.

2.5 System/Operation Modifications in the Event of a Water Quality Set-Point Exceedance

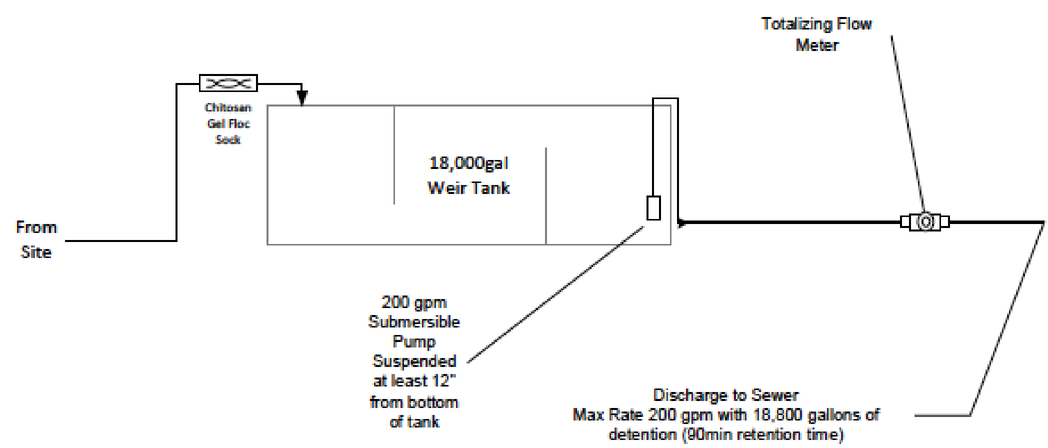
If water quality benchmarks are exceeded the operator of the treatment system will immediately take manual grab samples to confirm the online pH and Turbidity readings. The system will automatically recycle any water that has turbidity higher than the designated set-point or pH out of the acceptable range through the treatment train. If parameter set-points are exceeded the following may be implemented:

PARAMETER	ACTIONS TAKEN/ MODIFICATIONS
All	Ensure treatment system is functioning properly, make any necessary repairs and/or perform maintenance.
Turbidity	Slow down treatment system (increase settling). Add additional pre-injection port prior to Primary Tanks Review and revise offloading process to further reduce solids during water transfer from spoils barge.
pH	If pH is above 8.5 implement carbon-dioxide sparingly, if pH is more than 0.2 SU below background implement sodium hydroxide addition at Primary treatment detention tanks. It is unlikely that pH adjustment will be necessary as we expect the dredge water to have the same pH as the river water (neutral). Background would be the pH upstream which would be taken as part of the daily water quality compliance reporting.
DO	Place diffuser on effluent discharge pipe above the water line.

Temperature	Review holding settling time, close tank lids, process water as quickly as possible.
Metals	Total metals in the treated water should be less as the metals associated with particles are removed. If dissolved metals are exceeded, a multi-step pH adjustment system, ion exchange, ultra-filtration or electrocoagulation system could be implemented, however this is not anticipated in this project.
PCBs	Total PCBs in the treated water should be reduced as the PCBs associated with particles are removed. If dissolved PCBs are exceeded the granular activated carbon (GAC) vessels planned for the TSCA work will be mobilized early. If GAC has already been mobilized additional vessels would be deployed and/or the media replaced within 12 hours.

3.0 Upland Water Treatment System Design

The upland stockpile water treatment system is designed to meet the discharge requirements to the King County Industrial Waste sanitary sewer system. The upland treatment train is a simple pump and treat system that relies on passive coagulation. This system has been used on numerous construction sites in the greater Seattle area served by the combined sewer system. A Discharge Authorization Letter will be obtained from King County Industrial Waste prior to discharging any treated water to the sanitary sewer system. It is anticipated that this system will be needed for approximately two weeks with work occurring in the dry season.



3.1 Upland Treatment Train

Water from the upland work areas and/or shoreline bank soils stockpile area will be pumped to a detention tank for settling. The stockpile area will be built with an impermeable PVC liner, crushed rock, and ecology blocks. Ecology blocks will be placed around the three sides of the stockpile area. A PVC liner will be placed over the blocks and down onto the footprint of the stockpile area. As necessary, additional subgrade will be placed below the liner and graded to facilitate gravity drainage of water (water that passively leaves the materials in the stockpile area or rainfall) that comes into contact with the overlying liner. Permeable crushed rock will then be placed on top of the liner as a protective layer and a berm will be formed against the ecology blocks. The installed liner will be graded to a slope so as water passively leaves the soil it will flow to the enclosed section of the stockpile area for a 4” pump to remove the water and process it through the water treatment system as defined in the Water Treatment Plan, Appendix G of the RAWP. As the water is pumped to the tank it will pass through a chitosan gel-floc sock. This is a passive means of adding Chitosan to promote coagulation and settling of solids. After settling, the clarified water will be passed through a non-resettable flow meter/totalizer and discharge to the designated sanitary sewer structure on the Jorgensen Forge property.

4.0 Dredge Water Management

4.1 Equipment

Figure 1 depicts the type and general layout of the in-water equipment.

4.1.1Sediment Barge

The flat deck barges KP1 and KP2 will be used to hold the dredge spoils. The barge details are described further in the Vessel Management Plan, Appendix I of the RAWP. The barges will have a temporary barrier wall constructed approximately one third of the way from the stern of the barge. The weir will be constructed with Ecology blocks running from one side of the barge to the other. This will create two benefits for the management of dredge water; 1) it will cause the barge to slope from the heel to the stern promoting gravity drainage to that side of the barge 2) it will create a barrier that will keep the sediment from mixing with the water removal pumps. Woven geotextile and straw wattles will be placed on the stern side of the barrier wall to act as a passive filtration system to assist in lowering turbidity levels before reaching the floating water treatment system.

4.1.2 Water Treatment Barge

The water treatment barge will be the Flexi-Float barge. The barge is 50’x120’ and is described in further detail in the Vessel Management Plan, Appendix I of the RAWP. The water treatment barge will house the water treatment system as described in Section 2.

4.2 Dredge Water Removal

The excavator operator will place the dredge sediment onto the spoils barge in front of the barrier wall. Due the positioning of the barrier wall the water will flow towards the stern of the barge, through the barrier wall, and filtration media. A 6” Godwin pump will be located on the water treatment barge, which will be rafted directly next to the sediment barge. The Godwin Dri-Prime 6" (150mm) CD150M automatic priming centrifugal pump is able to handle solids up to 3" (75mm) in diameter, maximum flows of 1700 GPM (385.9 m3/h) and 160' (48.8 m) of total dynamic head, and indefinite dry-running capabilities. A 50’ flexible line will be run from the Godwin pump and placed into the stern of the sediment barge. It is anticipated that the water flow rates from dredging operations will be approximately 168 gallons per minute. The water will be removed from the stern of the sediment barge and pumped directly into the primary treatment detention tanks of the water treatment system. The close proximity of the sediment and water treatment barge will help mitigate the inherit risk of a pump line failing. Two smaller submersible pumps will be located on the sediment barge and will be used to remove any standing water that may develop in the bow section of the sediment barge. The submersible pumps will pump the standing water from the bow into the stern side of the barge for removal by the Godwin pump.

4.3 Water Treatment Operations and Maintenance

The water treatment is a critical piece of dredge support equipment, which will require 24 hour per day operation for the 6 day dredging work week. Pacific Pile & Marine (PPM) is committed to operating this plant in a manner to ensure water discharged has met the water quality objectives at the applicable EPA-required compliance points. Water treatment workers will be responsible for overseeing the safe operation of the system. During dredging activities, PPM laborers will monitor various components of the treatment system.

Due to the anticipated variability of the incoming dredge water, it will be necessary to adjust the treatment system to provide assurance that water quality objectives can be met. PPM will subcontract with WaterTectonics to provide Water Treatment Technicians to provide this service. The technicians will be knowledgeable with the system design and have performed water treatment system management previously. These technicians will continually monitor turbidity levels at various points in the treatment system and adjust the system as required. PPM will utilize one laborer during the day to assist WaterTectonics’ technician. At night two laborers will be used to ensure the mechanical portions of the system are operating correctly. The laborers will routinely walk the system checking tank levels, piping connections, valving, etc. to ensure proper operation of the system.

4.4 Treated Water Discharge

Treated water meeting the PPM water quality set-points, will be pumped through 6-inch diameter high-density polyethylene pipe into the LDW at the approximate location of dredging. The pipe will discharge from the bow of the dredge barge.

5.0 Upland Water Management

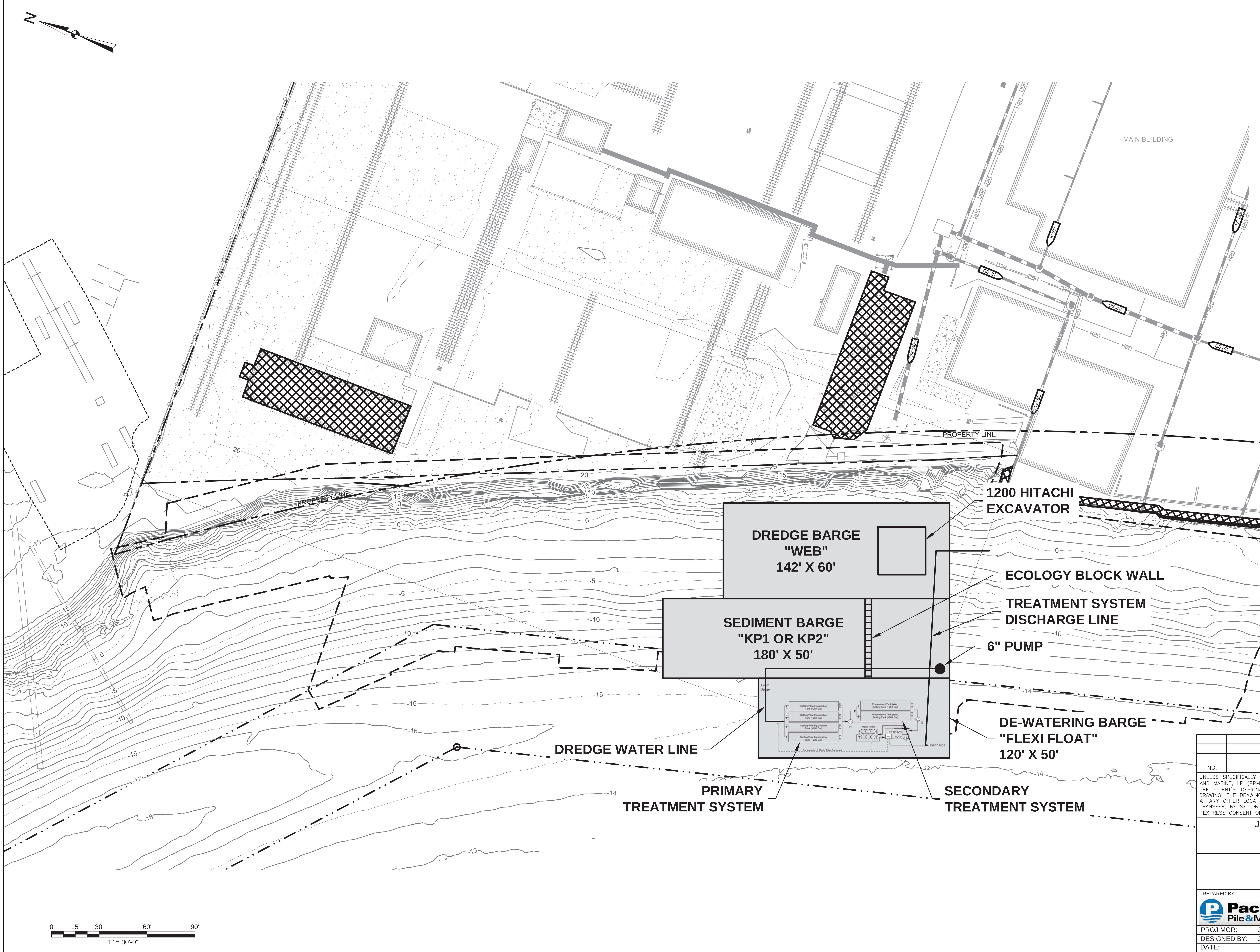
5.1 Upland Water Removal

Soil removed from the shoreline bank excavation areas will be placed into the upland stockpile area for dewatering prior to disposal. The stockpile area will be built with an impermable PVC liner, crushed rock, and ecology blocks. Ecology blocks will be placed around the three sides of the stockpile area. . The crushed rock will be graded to a slope so as water passively leaves the soil it will flow to the enclosed section of the stockpile area to a sump. A PVC liner will be placed over the blocks and down onto the crushed rock footprint of the stockpile area. Additional crushed rock will then be placed on top of the liner and a berm will be formed against the ecology blocks.The sump will have a 4" Godwin pump that will discharge the water through a chitosan gel floc sock and into one 18,000-gallon post-treatment weir tank.

5.2 Treated Water Discharge

Water from the weir tank will be sampled and tested for compliance with the King County Industrial Waste Program permit. The water in the tank will be sampled and tested for compliance with the King County Industrial Waste Program Permit. If treatment to King County discharge limits are not attainable the water will be disposed of at an authorized disposal facility such as Clean Harbors located in Kent, Washington.

Figure 1- Dredge and Dredge Water Treatment Equipment



LEGEND:

- NAVIGATION CHANNEL
- EXISTING CONTOUR (1 FT INTERVAL)
- SAND BAG/FILTER GRAVEL BERM
- APPROXIMATE TOP OF BANK
- EXISTING BOEING SHEETPILE WALL
- CONTAINMENT BARRIER (DO NOT DISTURB)
- TEMPORARY SECURITY FENCE
- STRUCTURES TO BE PRESERVED AND PROTECTED ADJACENT TO DREDGE/EXCAVATION LIMITS

NO.	ISSUE/DESCRIPTION	BY	DATE

JORGENSEN FORGE EARLY ACTION AREA
DUWAMISH WATERWAY
SEATTLE, WASHINGTON

DREDGE EQUIPMENT LAYOUT
PLAN VIEW

PREPARED BY: Pacific Pile & Marine, LP, Seattle Office, 582 South Riverside Drive, Seattle, WA 98108

PREPARED FOR: EARLE M. JORGENSEN COMPANY

PROJ MGR: JC	REVIEWED BY: JC	CHECKED BY: JC	FIGURE
DESIGNED BY: JC	DRAWN BY: JC	SCALE: AS NOTED	4
DATE: 03/14/2014	PROJECT NO.	REVISION NO. 0	SHEET NO. 1 OF 1

Appendix A- General Use Level Designation and MSDS for StormKlear Liqui-Floc™ 1% Chitosan solution

March 2007

(Updated January 2008)

USE DESIGNATIONS FOR EROSION AND SEDIMENT CONTROL

for

Chitosan-Enhanced Sand Filtration using StormKlear™ LiquiFloc™

<u>Ecology's Decision:</u>

Based on Ecology's review of Natural Site Solutions' (NSS) and HaloSource's application submissions and the findings by the Chemical Technical Review Committee, (CTRC) Ecology is hereby issuing the following use level designations for the chitosan-enhanced sand filtration (CESF) technology for adequately controlling small particulate turbidity (clays, silt, etc.) in stormwater discharges at construction sites:

1. **General Use Level Designation for the CESF technology with the discharge of chitosan acetate treated water to retention systems capable of infiltrating all storms to the ground with no discharge to surface water. The design of the infiltration system must be based on the criteria in Volume V of Ecology's most recent Stormwater Manual for Western Washington. The design and operational criteria for the CESF specified in this document shall also be strictly adhered to. Records showing that total retention was achieved must be kept on site.**

2. **General Use Level Designation for the CESF technology with a discharge of chitosan acetate treated water from the sand filters to temporary holding ponds or basins then discharged to surface water (batch treatment). The design and operational criteria specified in this document shall be strictly adhered to.**

3. **General Use Level Designation for the CESF technology with the chitosan acetate treated discharges conveyed directly or indirectly to surface water (flow-through system).**

This designation has no expiration date, but it may be amended or revoked by Ecology and is subject to all conditions contained in this use level designation.

Conditions Applicable to CESF under this GULD

1. **Formal written approval from Ecology is required for the use of chemical treatment at each site. Written approval must be obtained from the appropriate Ecology regional office.**

2. **This use level designation applies only to StormKlear™ LiquiFloc™ (1% chitosan acetate solution).**

3. **The chitosan dose rate for water entering the filters shall not exceed 1 mg/L StormKlear™ LiquiFloc™ (as chitosan by weight). All calibration results must be recorded simultaneously with the flowrates and kept on site.**

4. **Source control procedures shall be implemented to the maximum extent feasible to minimize the need for the use of additional chitosan acetate for the pretreatment of stormwater. Additional StormKlear™ LiquiFloc™ (amounts greater than 1 mg/L chitosan by weight) may be used to pretreat water that exceeds 600 NTU. A portion of the 1 mg/L StormKlear™ LiquiFloc™ may be used to pretreat water less than or equal to 600 NTU. Pretreatment must occur in a tank or basin dedicated to pretreatment. All pretreated water must enter the sand filters. Pretreated water must have no less than 50 NTU and no more than 600 NTU before final dosing. This will help ensure that free chitosan does not enter the CESF system. Also, 1 mg/L StormKlear™ LiquiFloc™ (chitosan by weight) is sufficient to treat water in this range. Water exiting the pretreatment tanks must be continuously monitored for turbidity. An automatic integrated turbidity sensor shall be located on the output from the pretreatment tanks or basins. This sensor will alert the operator when the turbidity values fall outside of the 50 to 600 NTU range. If this occurs, operators can reroute the out of spec water to the untreated stormwater pond, shut the system down, or conduct additional residual chitosan tests. One of these actions must occur each time the alarm goes off. Jar tests must be used to determine proper pretreatment dosing and proper treatment dosing.**

5. **This approval only applies to discharges to streams. Additional aquatic toxicity testing will be necessary for discharges to other waterbodies.**

6. **Jar tests will be conducted at startup to determine the dosage level of chitosan acetate solution. Additional jar tests will be conducted when influent turbidity changes by 20% or greater. Jar test results must be recorded in the daily operating log. If the results of the jar test indicate that the dose needs to be adjusted, the jar testing results and the indicated dose rate change shall be documented in the daily operating log.**

7. During CESF operation, water quality influent and effluent shall be continuously monitored for pH, turbidity, and flow. For batch treatment systems, only water discharged from the batch treatment basins or tanks must be continuously monitored for pH, turbidity, and flow during discharge.

8. The discharge flowrate shall be continuously metered and recorded. For batch treatment systems, only water discharged from the batch treatment basins or tanks must be continuously monitored for flowrate.

9. The effluent shall be monitored for residual chitosan or aquatic toxicity. If effluent will be monitored for aquatic toxicity, the most sensitive test reported in the intended use plan must be used. If the effluent will be monitored for residual chitosan, a discrete grab sample of homogeneous sand filter discharge must be collected and analyzed within 30 minutes of the onset of operation and 2 hours after startup to confirm a discharge concentration below 0.2 ppm. The test is to be repeated whenever there is a change in dosage, or a significant change in influent turbidity or flowrate (20% or greater). For batch treatment systems, only water discharged from the batch treatment basins or tanks must be monitored. For batch treatment systems, an additional grab sample of the potential batch treatment discharge must be collected and analyzed for aquatic toxicity or residual chitosan before any discharge from treatment basins or tanks can occur.

10. Discharges from the CESF shall be maintained below 0.2 ppm residual chitosan at all times. Discharges must be monitored for residual chitosan or aquatic toxicity. In the event that the chitosan residual in the discharge is greater than 0.2 ppm, the discharge exhibits aquatic toxicity, or when the CESF system fails to meet discharge quality requirements, a contingency plan must be included in every SWPPP that immediately corrects the situation. The operation and maintenance manual must include contingency plan measures and must be available on-site.

11. An Operating Period Information Form shall be completed for each operating period (system startup, operation, and shutdown). At a minimum, the form shall include the following:

- **A record of each recycle event**
- **A record of each backwash event**
- **Actions taken when a recycle event occurs**
- **Actions taken when excessive backwashing is occurring**
- **A record of pump calibration**
- **A record of chitosan use for pretreatment**

- **A record of chitosan dosage immediately prior to filters**
- **A record of test results for chitosan residual in the effluent**

Weekly, the supervisor shall examine the forms completed the previous week. The supervisor shall sign each daily form indicating it has been reviewed and document actions taken in response to any abnormal conditions observed by the operator.

12. **At all construction sites, at the end of the operating period, a delegated responsible person shall record their assessment of the operational efficiency of the CESF process, any upsets, the sand filter discharge chitosan concentrations, and any other relevant observations that relate to CESF proper operation. They must also certify the acceptability of the CESF discharge to surface water.**

13. **Discharges from the CESF system shall not cause or contribute to receiving water quality violations and shall comply with the discharge requirements of the State of Washington Construction Stormwater General Permit, AKART, and local government requirements for turbidity and other applicable pollutants. This designation document must be used as the basis for Stormwater Pollution Prevention Plans (SWPPPs) for all construction projects where chitosan treatment is planned.**

14. **Discharges from the CESF system under these designations shall achieve performance goals of a maximum instantaneous discharge of 10 NTU turbidity and a discharge pH within a range of 6.5-8.5. These limits reduce interferences associated with the residual chitosan test.**

15. **The CESF facility contractor shall guarantee that the CESF system, when used as directed, will not produce treated water that exhibits aquatic toxicity caused by chitosan added as a treatment agent.**

16. **The CESF system shall only be operated by a trained technician certified through an Ecology-approved training program that includes classroom and field instruction. The CESF operator must remain on-site during CESF operation. The technician must have the following minimum training requirements:**

Prerequisites:

- **Current certification as a Certified Erosion and Sediment Control Lead (CESCL), through an Ecology-approved CESCL training course.**
- **Fundamental knowledge of, high-pressure sand filter systems.**
- **Fundamental knowledge of water pumping and piping systems.**
- **Fundamental knowledge of stormwater discharge regulations for applicable region/locale.**

- **Fundamental knowledge of stormwater quality testing procedures and methods for parameters applicable to the region/locale.**

Classroom (8 hours)

- **Stormwater regulatory framework and requirements**
- **Stormwater treatment chemistry (chitosan, pH, coagulation, filtration, etc.)**
- **Stormwater treatability (how to do jar testing)**
- **Treatment system components and their operation**
- **Treatment system operation**
- **Troubleshooting**

In the field (32 hours)

- **Operating the treatment system**
- **Entering data in the system operations log**
- **Testing turbidity and pH**
- **Optimizing chitosan dose rate**
- **Water quality sampling and testing (turbidity and pH)**
- **Residual Chitosan Test**

17. **The SWPPP is to include a field procedure, accepted by the Department of Ecology, for detecting residual chitosan in stormwater discharges sensitive to 0.2 ppm.**

18. **During the planning of the project, the adverse potential impacts on chitosan efficiency of the use of other erosion and sediment control practices must be evaluated.**

Design Criteria for CESF Systems:

1. **Systems must be designed using the relevant portions of the most current versions of BMP C250 and BMP C251 of the Western and Eastern Stormwater Management Manuals. The most recent versions can be found: http://www.ecy.wa.gov/programs/wq/stormwater/wwstormwatermanual/final_bmp_c250_12_06.pdf. System design must consider downstream conveyance system integrity.**

2. **The facility shall employ a minimum of three (3) sand filter pods to ensure adequate backwashing capacity. The backwash slurry from the sand filters must be discharged to a holding cell that is separate from the temporary storage cell for the incoming turbid stormwater. The overflow from the backwash slurry detention cell can overflow into the detention basin for the incoming turbid stormwater.**

3. **The operating flow rate shall not exceed 15 GPM per square foot of sand bed filtration area.**

4. **Only filtration media approved in the Sand Filtration Treatment Facilities section (Volume V, Chapter 8) of the most recent Western Washington**

Stormwater Manual can be used in the filter pods. Minimum sand bed depth shall be 18 inches underlain with a minimum of 6 inches of 1-inch crushed rock.

5. **The CESF system shall include a flow-regulating valve on the input to and output of the sand filter. These regulating valves will reduce the maximum output of the pump as required and facilitate proper backwash.**

6. **The CESF system treated water output shall be equipped with an automatic integrated turbidity and pH sensor capable of shutting the system down if the output turbidity or pH exceeds preset values. An audible alarm and warning light shall be installed on the treatment system to alert the operator in the event of a system failure.**

7. **The CESF control system (including metering pump, chitosan storage and instrumentation) shall be completely enclosed in a secure structure with locking door. The chitosan liquid concentrate shall be stored in a non-corrosive storage tank. Chitosan storage tank, metering pump, and tubing shall have secondary containment. The metering pump discharge tubing shall have an anti-siphon valve.**

8. **Chitosan injection shall be performed with an LMI-brand C77 high viscosity pump head, electric metering pump, or equivalent. The metering pump must be calibrated within 15 minutes of the beginning of each operating period. The metering pump shall be recalibrated when a significant change occurs in either the flow or influent turbidity.**

Applicant: HaloSource Inc., StormKlear™ LiquiFloc™ Manufacturer

Luke Conyac, Regulatory Affairs Counsel

Applicant Address: 1631 220th Street SE, Suite 100
Bothell, Washington 98021

Application Documents:

- Application for Conditional Short Term Use Designation for Chitosan Enhanced Sand Filtration, July 1, 2003, Peter Moon, P.E. and Paul Geisert, P.E., Price Moon Enterprises, Inc. for Natural Site Solutions, LLC. (NSS)

- Chitosan-Enhanced Sand Filtration. Engineering Report .with Addendum, NSS, May 15th, 2003

- Chitosan-Enhanced Sand Filtration System. Operation and Maintenance Manual. NSS, April 30, 2003.

- Toxicity Evaluations of Chitosan-based Products, Liqui-Floc and Gel-Floc: December 2002 and March 2003, AMEC Earth & Environmental Northwest Bioassay Laboratory, 5009 Pacific Hwy. East, Suite 2, Fife, WA 98424. (253) 922-4296.

- Understanding the Freshwater Aquatic Toxicity of Chitosan When Used in Engineered Sand Filtration Stormwater Treatment Systems; March 27, 2003. John Macpherson, CPESC, NSS.

- Analytical Testing Demonstrating the Inability of a Solution of Chitosan Acetate to Penetrate a Model Sand Filter; John Macpherson, NSS.

- Quality Assurance Project Plan, Third Version, January 12, 2004, John MacPherson, NSS

- Technical Engineering Evaluation Report (TEER) For The Chitosan-Enhanced Sand Filtration Technology for Flow-Through Operations, Gary Minton, February 28, 2006

- Rainbow trout (Oncorhynchus mykiss) Chronic Toxicity Screening of Stormwater Treated by Chitosan Enhanced Sand Filtration Flow-Through System – Redmond, Washington, ECO-Endeavors, Inc, June 2, 3004

- Toxicity testing for Liqui-Floc: Final Report, Nautilus Environmental, LLC, September 30, 2004

- Colorimetric Determination of Residual Chitosan in Treated Stormwater: Field Test, Natural Site Solutions, LLC, July, 2004

- Certification of Residual Chitosan Test by AM TEST Laboratories, October 27, 2005

- Chitosan-Enhanced Sand Filtration System Using StormKlear™ LiquiFloc™ Operations and Maintenance Manual, HaloSource, February, 2007

Applicant's Use Level Request:

General use level designation for the operation of flow-through Chitosan-Enhanced Sand Filtration (CESF) technology for the reduction of turbidity in construction site stormwater.

Applicant's Performance Claims:

For construction site stormwater runoff with a turbidity of less than 600 NTU (influent), a properly engineered and deployed *Chitosan-Enhanced Sand Filtration System* will remove greater than 95% of the turbidity, producing effluent that will consistently meet the state surface water discharge standards.

Chemical Technical Review Committee (CTRC) Recommendation:

After reviewing the Technical Evaluation Engineering Report and supporting documents, the CTRC finds sufficient evidence to recommend to Ecology to grant a general use level designation (GULD) for a flow-through CESF technology using StormKlear™ LiquiFloc™ that can remove turbidity from stormwater at construction sites within acceptable limits.

Findings of Fact:

A CESF system charged with #30 crushed silica sand has demonstrated the ability to reduce turbidity caused by the disturbance of sediment on construction sites by 97.44 percent (overall average) when operated at a flowrate of approximately 15 gallons per minute per square foot of filtration surface area. This translates to a flowrate of approximately 500 GPM when using a 48-inch diameter, 4-pod sand filter module.

1. Over 1500 operating periods were monitored over a two-year period. Data from these operating periods show that discharge graphs were always below 10 NTU. Any discharge that exceeded 10 NTU was recycled. Recycle rates ranged from 4-17%.

2. Influent turbidity levels above 600 NTU demonstrated the potential to cause a slow degradation of the turbidity removal performance by the system resulting in eventual system failure. CESF systems shall be limited to influent turbidity levels of 600 NTU or less**.** Turbidity levels above 600 NTU shall be allowed additional settlement time or be pretreated.

3. Water with a pH range outside the CESF treatment window of 6.5 to 8.5 shall be pretreated to achieve this range. This pretreatment process is not covered in this application.

4. In the CESF treatment systems that have been constructed and operated to date no aquatic toxicity has been observed in the treated filtrate.

5. The chitosan acetate polymer component, used for water treatment, is non-toxic to humans and other mammals, which makes it somewhat unique in the universe of treatment agents. Chitosan acetate does, however, exhibit toxicity to rainbow

trout and should therefore be used at a maximum dose rate of 1 mg/L as chitosan acetate by weight as a conservative measure to ensure no possibility of toxicity to rainbow trout in receiving water.

6. HaloSource provided a design/operation/maintenance manual, which includes information on selecting, sizing, assembling, operating and maintaining a CESF system.

7. NSS and HaloSource provided a significant amount of aquatic toxicity data demonstrating that the discharge residual of the chitosan acetate polymer is expected to be within toxicity levels acceptable to Ecology when used as directed.

8. NSS and HaloSource provided other supporting information including system limitations and constraints, system specifications and warranty information.

Description of the Technology:

Chitosan-enhanced sand filtration (CESF) is a stand-alone construction site water treatment technology, which is comprised of four basic components:

- Stormwater transfer pump
- Chitosan addition
- Pressurized multi-pod sand filtration
- Interconnecting treatment system piping

CESF can be used as a flow-through stormwater treatment technology that utilizes chitosan, a natural biopolymer, in conjunction with pressurized sand filtration to remove turbidity (suspended sediment). Each treatment system is designed and installed to be operated on an as need basis, pumping water from a retention basin whenever the water level of the retention basin is high enough to warrant processing. When stormwater is transferred from the retention basin to the sand filtration unit, chitosan is introduced to stormwater to coagulate suspended solids producing larger particles, which are retained within a sand filter. The filtration systems are equipped with automatic backwash systems, which will backwash the collected sediment from the individual filter pods as necessary to maintain the hydraulic capacity of the filtration media. This feature allows the treatment system to operate on a continuous flow-through basis. A link to a diagram of the system is included here:

Chitosan Enhanced
Sand Filtration 3-Cell

Recommended Research and Development

Ecology encourages HaloSource to pursue continuous improvements to the CESF system. To that end, the following actions are recommended:

- Further research should be conducted to create a more reliable residual chitosan test. A test that quantifies chitosan concentrations should be developed.
- Determine how different soil types affect chitosan treatment.
- Determine aquatic threshold for marine species.

Contact Information:

HaloSource Contact: Frank Kneib, National Sales Manager
Storm & Industrial Water Division
Toll Free: 888-282-6766 Ext 1970
Office: 425-974-1970
Fax: 425-556-4120
Cell: 602-334-3474
Email: fkneib@halosource.com

HaloSource Website: www.halosource.com

Ecology web link: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

Ecology: Mieke Hoppin
Water Quality Program
(360) 407-6435
mhop461@ecy.wa.gov

CTRC: Jeff Dendy, P.E.
City of Redmond
(425) 556-2890
jdendy@ci.redmond.wa.us

Date: 9/27/2011
Revision: 00

Material Safety Data Sheet
HaloKlear® LiquiFloc™ 1%

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

Manufacturer's Name:	HaloSource, Inc.
Corporate Address:	1631 220th St. SE, Suite 100, Bothell, WA 98021
Manufacturer's Telephone:	(425) 881-6464 (Monday-Friday, 8AM-5PM PDT)
Emergency Telephone (24 Hours):	**800-424-9300 CHEMTREC (Domestic, North America)** **703-527-3887 CHEMTREC (International, collect calls accepted)**
Material/Trade/Product Name:	**HaloKlear® LiquiFloc™ 1%**
Synonyms:	None
Chemical Name:	Chitosan Acetate Solution
Chemical Formula:	Not available
CAS No.:	Not applicable
EPA Registration #:	Not applicable
Product Use:	Flocculates soil contamination in stormwater.

SECTION 2: COMPOSITION/INFORMATION ON INGREDIENTS

CAS NO.	COMPONENT	%	OSHA HAZARDOUS?
Trade Secret	Trade Secret	2	NO
	All other components are non-hazardous.	98	NO

NOTE: See Section 8 for permissible exposure limits.

SECTION 3: HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Clear to pale yellow viscous liquid with a pungent vinegar odor.

May be mildly irritating to eyes. Not likely to be hazardous to skin, respiratory tract, or by ingestion.

POTENTIAL HEALTH EFFECTS

EYE: May be mildly irritating to eyes.

SKIN: Not hazardous to skin.

INHALATION: Not likely to be hazardous by inhalation.

INGESTION: Not likely to be hazardous by ingestion.

CHRONIC EXPOSURE/CARCINOGENICITY: None of the components present in this material at concentrations of equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as a carcinogen.

SIGNS AND SYMPTOMS OF OVEREXPOSURE: Eye irritation.

AGGRAVATION OF PRE-EXISTING CONDITIONS: None known.

POTENTIAL ENVIRONMENTAL EFFECTS: Material is 100% biodegradable and nontoxic.

SECTION 4: FIRST AID MEASURES

FIRST AID PROCEDURES

EYE CONTACT: Remove contact lenses (if applicable), flush with water for 15 minutes. Call a physician.

SKIN CONTACT: Cleansing the skin after exposure is advisable.

INHALATION: If large amounts of fumes are inhaled, remove to fresh air and consult a physician.

INGESTION: Consult a physician if necessary.

NOTE TO PHYSICIANS: None.

SECTION 5: FIRE FIGHTING MEASURES

FLASH POINT: Not available
UPPER FLAMMABLE LIMIT: Not available
FLAMMABLITY CLASS (OSHA): Not applicable

AUTOIGNITION TEMPERATURE: Not available
LOWER FLAMMABLE LIMIT: Not available
FLAME PROPAGATION/BURNING RATE: Not available

UNIQUE FIRE PROPERTIES: None known.

HAZARDOUS COMBUSTION PRODUCTS: None.

EXTINGUISHING MEDIA: Does not burn. Use water, dry chemicals, carbon dioxide, sand or foam. Use extinguishing media appropriate for surrounding fire.

PROTECTION OF FIREFIGHTERS: Do not enter confined fire space without full bunker gear (helmet with face shield, bunker coat, gloves and rubber boots), including a positive pressure NIOSH approved self-contained breathing apparatus. Water may be used to keep fire-exposed containers cool until fire is out.

SECTION 6: ACCIDENTAL RELEASE MEASURES

PERSONAL PROTECTIVE EQUIPMENT: See Section 8 (Personal Protective Equipment).

ENVIRONMENTAL PRECAUTIONS: Material is 100% biodegradable and nontoxic.

METHODS FOR CLEANING UP: Dilute with water and hose down.

SECTION 7: HANDLING AND STORAGE

SAFE *HANDLING* RECOMMENDATIONS

VENTILATION: General ventilation should be sufficient under normal conditions.

FIRE PREVENTION: Non-flammable, no special fire protection required.

SPECIAL HANDLING REQUIREMENTS: Avoid eye contact.

SAFE *STORAGE* RECOMMENDATIONS

CONTAINMENT: The container should be kept covered to prevent contamination.

STORAGE ROOM RECOMMENDATIONS: Store in a cool, dry, well-ventilated area away from direct heat.

INCOMPATIBLE MATERIALS: Strong oxidizing material and strong bases.

STORAGE CONDITIONS: 10-50°C recommended (will freeze @ ~3°C). Shelf life is indefinite but viscosity will decrease over time.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS: General ventilation should be sufficient under normal conditions.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

EYE/FACE PROTECTION: Safety glasses recommended.

SKIN PROTECTION: For operations where skin contact can occur, wear impervious clothing such as apron, boots, or whole bodysuit.

HAND PROTECTION: For operations where hand contact can occur, rubber gloves recommended.

RESPIRATORY PROTECTION: A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrant a respirator's use. Respirator use is not required for this product.

GOOD HYGEIENE/WORK PRACTICES: Always follow good hygiene/work practices by avoiding vapors or mists and contact with eyes and skin. Thoroughly wash hands after handling and before eating or drinking. Always wear the appropriate PPE when repairing or performing maintenance on contaminated equipment.

EXPOSURE GUIDELINES

PERMISSIBLE EXPOSURE LIMITS						
INGREDIENT CAS NO.	OSHA		WISHA		ACGIH (TLV)	
	TWA	STEL	TWA	STEL	TWA	STEL
Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

COLOR: Clear to pale yellow
PHYSICAL FORM: Viscous liquid
pH: 3.0-4.5
VAPOR DENSITY: Not available
MELTING POINT: Not available
SOLUBILITY IN WATER: Soluble

SHAPE: Viscous liquid
ODOR: Pungent vinegar odor
VAPOR PRESSURE: Not available
BOILING POINT: 211°F
FREEZING POINT: Not available
SPECIFIC GRAVITY OR DENSITY: 1.0-1.1 g/mL

NOTE: These physical data are typical values based on material tested but may vary from sample to sample. Values should not be construed as a guaranteed analysis of any specific lot or as specifications.

SECTION 10: STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable.

CONDITIONS TO AVOID: Freezing temperatures or excess heat (for quality purposes).

MATERIALS TO AVOID (INCOMPATIBILITY): Strong oxidizing material and strong bases.

HAZARDOUS DECOMPOSITION PRODUCTS: Decomposition will not occur.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11: TOXICOLOGICAL INFORMATION

ORAL LD_{50} (rat): Not available.

DERMAL LD_{50} (rabbit): Not available.

SKIN IRRITATION: Not available.

EYE IRRITATION: Not available.

SKIN SENSITIZATION: Not available.

ADDITIONAL INFORMATION:

SECTION 12: ECOLOGICAL INFORMATION

ECOTOXICITY (in water):

- Acute:
  - Daphnia LC 50 – 1369 mg/ L
  - Daphnia NOEC – 1000 mg/L
  - Fathead minnows LC 50 – 642 mg/L
  - Fathead minnows NOEC – 500 mg/L
  - Rainbow Trout LC 50 – 173mg/L
  - Rainbow Trout NOEC – 125 mg/L
- Chronic:
  - Rainbow Trout LC 50 – 154 mg /L

- Rainbow Trout LC 25 – 121 mg/L
- Fathead Minnow LC 50 - > 1000 mg/L
- Fathead Minnow LC25 – 932 mg/L

MOBILITY: Not available.

PERSISTENCE AND DEGRADABILITY: Not available.

BIOACCUMULATIVE POTENTIAL: Not available.

ADDITIONAL INFORMATION: Not available.

SECTION 13: DISPOSAL CONSIDERATIONS

If this product as supplied becomes a waste, it does not meet the criteria of a hazardous waste as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR 261. Please be advised that state and local requirements for waste disposal may be more restrictive or otherwise different from federal regulations. Consult state and local regulations regarding the proper disposal of this material.

NOTE: Chemical additions, processing or otherwise altering this material may make the waste management information presented in this MSDS incomplete, inaccurate or otherwise inappropriate.

SECTION 14: TRANSPORT INFORMATION

U.S. DEPARTMENT OF TRANSPORTATION (DOT):

Proper Shipping Name:	Not Regulated
Hazard Class:	Not Regulated
Identification Number (UN Number):	Not Regulated
Packing Group (PG):	Not Regulated

SECTION 15: REGULATORY INFORMATION

TSCA STATUS: The substances in this preparation are included on or exempted from the TSCA 8(b) inventory (40 CFR 710).

CERCLA REPORTABLE QUANTITY (RQ):

CHEMICAL NAME	RQ
Not applicable	Not applicable

SARA TITLE III SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (EHS):

CHEMICAL NAME	TPQ	RQ
Not applicable	Not applicable	Not applicable

SARA TITLE III SECTION 311/312 HAZARD CATEGORIES: Does this product/material meet the definition of the following hazard classes according to the EPA 'Hazard Categories' promulgated under Sections 311 and 312 of SARA Title III?

ACUTE HEALTH HAZARD	CHRONIC HEALTH HAZARD	FIRE HAZARD	REACTIVE HAZARD	SUDDEN RELEASE OF PRESSURE
NO	NO	NO	NO	NO

SARA TITLE III SECTION 313 TOXIC CHEMICALS INFORMATION:

CHEMICAL NAME	CAS NO.	CONCENTRATION (%)
Not applicable	Not applicable	Not applicable

CALIFORNIA PROPOSITION 65: The following chemical(s) is/are known to the state of California to cause cancer or reproductive toxicity:

CHEMICAL NAME	CAS NO.	CONCENTRATION (%)
Not applicable	Not applicable	Not applicable

SECTION 16: OTHER INFORMATION

REVISION INFORMATION:
MSDS sections(s) changed since last revision of document:

- None, this is a new MSDS.

DISCLAIMER:
****
The above information is based upon information HaloSource, Inc. believes to be reliable and is supplied for informational purposes only. HaloSource, Inc. disclaims any liability for damage which results from the use of the above information and nothing contained therein shall constitute a guarantee, warranty (including fitness for a particular purpose) or representation with respect to the accuracy or completeness of the data, the product described or their use for any specific purpose even if that purpose is known to HaloSource, Inc. The final determination of the suitability of the information, the manner of use of the information or product and potential infringement is the sole responsibility of the user.
****

MSDS PREPARED BY: Jeremy Heath, EH&S Manager

Appendix B- O&M Manual and Supporting Operational Information

WATERTECTONICS

Chitosan Enhanced Sand Filtration
with the
Road Side Assist (RSA)

OPERATIONS AND MAINTENANCE MANUAL

Example Only – Site specific information to be added

Prepared by:

Water Tectonics, Inc.
Rev 02/07/2010

6300 Merrill Creek Parkway, Suite C-100, Everett, WA 98203 Tel: 425.349-4200 Fax: 425.349.4201 www.watertectonics.com

CONTENTS

APPENDICES

1 Introduction

The primary function of this manual is to help with the operation and maintenance of the project as it relates to the treatment of surface water runoff. The primary goal is to manage pollutants encountered during construction and to properly discharge treated stormwater to the specified surface water discharge locations. The manual has been prepared to give users of this system guidance in operating parameters, maintenance, inspection, monitoring and documentation. The system is composed of several elements that incorporate pH adjustment, turbidity reduction, and the management of monitoring parameters prior to discharge.

The State of Washington General Construction Stormwater Permit **WAR-000000** will be used as the key document governing water quality parameters for discharge from the system. The general use level designation for StormKlear™ as issued by the Department of Ecology along with BMP C250 will be used to design and dictate system operational parameters.

It may be necessary to modify, change or add additional components and features to the design of this water treatment system based on water characteristics and flow. Decisions that address these issues will be discussed in the field and presented for consideration if needed.

System footprint will cover approximately 8,900sf or app. 85’ X 105’

Please note that residual Chitosan testing during the use of Chitosan is critical and required by the Department of Ecology.

1.1 Enhanced Treatment System Design Primary Components

This system utilizes multiple physical and chemical treatments as noted in Appendix H Site drawing and Site Phase Drawing. The treatment system consists of four phases. The system flow design is rated at 1500 gpm. The system flow rate is based on the 10 year storm event which produces approximately 32 gallons per 100lf of work area. It is anticipated that work areas for the project could be up to 5000lf which is just over 1500 gpm. The system components are plumbed to treat and convey up to 1500 gpm. Additional detention has been included in the design to allow for the possibility of system down time for regular maintenance & consumable replenishment. The current design with four pretreatment detention tanks per 750 gpm CESF unit allows for two hours of down time during peak operations. Added benefits of the pretreatment tanks are flow equalization, increased settling time, and pH adjustment prior to Chitosan dosing, all of which optimize performance and reduce down time decreasing overall treatment cost.

Phase 1 Settleable Solids, pH Conditioning & Pre-treatment

Phase 1 consists of two open tanks plumbed in parallel. The influent water is analyzed for pH by submersible pH probe. The pH is lowered to an optimum reaction point by injecting carbon dioxide into a fine gas bubbler hose. Both hoses will be held down by inert sand ballast built into the hose. The Carbon dioxide injection will be controlled by a set of pH probes linked to a solenoid control system. This system is connected to a SC100 Hach controller that reads and adjusts the carbon dioxide feed rate duration. The two tanks then flow via gravity into multiple weir tanks. The over-under weir pattern in the tanks promotes the settling of large particles.

Phase 2 Turbidity Reduction

Phase 2 consists of pretreatment when influent turbidity exceeds 600 ntu. If pretreatment is required, Chitosan is injected prior to each pump for turbidity reduction. The rate of dosage would be decided via field testing by the operator. Chitosan, a derivative of chitin, is a natural biopolymer that is structurally similar to cellulose. Chitin is the major structural component in the shells of crustaceans such as shrimp, crabs and lobsters. Chitin and Chitosan also form the structural material of fungi cell walls.

The primary process occurring in these tanks is the removal of turbidity by the use of Chitosan. The water from these two tanks is merged into a single pipe and pumped through a Chitosan Enhanced Treatment System (CESF). These tanks will need to be monitored for sludge build up. A maintenance program, based on physical inspection, will be required to remove the sludge on a regular basis.

Phase 3 Chitosan Injection Systems and Monitoring

Phase 3 consists of the CESF trailer systems. Here, the influent pH and turbidity are monitored at a second injection point. Additional Chitosan is available for injection if needed. The function of the Chitosan in this stage is to convert particles smaller than 15 microns to particles larger than 20 microns so they can be removed by the sandfilters. The water is sent directly to two sets of sandfilters (Phase 4) to remove the flocculated particles. The water is then sent back to the CESF trailer to monitor pH and turbidity. The trailer controller is set up to either discharge the water or to send it back to tanks #1 and #2 for re-processing. This stage allows turbidity management of the incoming water. This is necessary to ensure that turbidity is in correct range for successful treatment.

Phase 4 Sandfilter Filtration

Phase 4 consists of sandfilters. The sandfilter removes particles that are 15-20 microns or larger from the treated effluent stream. The function of the Chitosan in this stage is to convert particles smaller than 15 microns to particles larger than 20 microns. The sandfilter will automatically backwash itself in order to avoid blinding at the interior upper level of the sandfilter bed. The water is sent from the sandfilter back to the CESF trailer to be monitored for pH and turbidity prior to discharge.

1.2 Training Requirements

Enhanced treatment systems are designed for ease of operation and consistency of results if operated and maintained by trained and experienced personnel. All operators should have at least one year of experience with pressurized sand filtration systems. In conjunction with this manual, operational training will be provided as described below. Water Tectonics will conduct both classroom and field training with selected Tri-State personnel.

Background Technical Prerequisites

1. Minimum one year working experience with pressurized sand filtration water clarification systems
2. Demonstrated ability to understand, commission, and troubleshoot water clarification systems
3. Demonstrated knowledge of applicable federal, state, and local regulations with regard to surface water management and potential failure impacts
4. Working knowledge of computerized control systems, data-logging equipment, and sample collection protocols

Classroom (4 hours)

1. Review of applicable stormwater regulations
2. Overview of applicable basic water chemistry (including the influence of suspended sediment loads, pH, and conductivity on stormwater clarification)
3. CESF system components, commissioning, operations, and maintenance
4. Troubleshooting the system and understanding programmable logic controller (PLC) operations
5. Detailed review of standard operating procedures with an emphasis on accurate written records maintenance
6. Detailed review of standard laboratory methods (clean methods, water chemistry, etc.) as well as CESF-specific field analysis protocol and documentation
7. Contingency planning and execution
8. Site specific health and safety guidelines

Field (8 hours with an additional 32 hours of on-the-job training under the supervision of an experienced operator)

1. System operation
2. Recording data in the operations log
3. Setting the PLC for automated systems
4. Calibrating monitoring equipment
5. Maintenance
6. Troubleshooting anticipated and unexpected problems

7. In-field contingency execution
8. In-field wet-method for analytical protocols
9. Proper documentation and chain-of-command reporting
10. Site specific health and safety guidelines

Each project will have one or more trained operators who will have, at a minimum, the experience listed above. The operator will evaluate whether the CESF system is operating within performance criteria, and/or take immediate corrective actions in the event of system bypass or failure to meet water quality specifications.

Some sites may have contractor-required awareness training. In these cases, contractors will specify training requirements and project managers will make aware and/or provide such training to the field technician prior to site access. All technicians will perform operations and systems inspections in accordance with generally accepted professional standards.

Operators who have received equivalent and documented training under other qualified CESF Operations & Maintenance Manuals will not require re-training. HaloSource or its distributors retain documentation of qualified trainers and operators.

2 System Components and Configuration

The flow capacity and corresponding system sizing will be determined by site size, volume of detention provided, contributing basin size, anticipated rainfall (wet season vs. dry season), operational frequency, and discharge requirements.

A schematic process flow diagram for this system is shown in **Appendix H**, and is cross-referenced to the list of system components described below.

1. **Water Quality Monitoring:** Inline pH and turbidity meters or probes are to be used to monitor both influent and effluent water quality. Influent water quality monitoring equipment will assist with system optimization – pre-dose rates of Chitosan and pH adjustment with sodium hydroxide or carbon dioxide. Grab samples are to be collected to verify these readings. The system must include an audio or visual alarm to indicate if effluent water quality is outside the allowed discharge range for pH and turbidity. The site technician will be responsible for monitoring the probe readings and making necessary adjustments including shutting down the system or diverting water that does not meet the required specifications to the detention structure. The data are to be recorded and displayed. Programmable logic controllers (PLC's) may be programmed to control the flow valves for recirculation/discharge.

2. **Influent Flow Meter:** An influent flow meter must be used to determine flow rates for StormKlear™ Liqui-Floc™ dose-rate calibration.

3. **PH Adjustment:** StormKlear™ Liqui-Floc™ is most effective within a specific pH range of 6.5 to 8.0 standard units. Should the influent water pH fall outside of this range, pH adjustment may be necessary. A CO_2 injection or other chemical neutralization system may be required to adjust the pH.

4. **StormKlear™ Liqui-Floc™ Bulk Storage:** A bulk container of StormKlear™ Liqui-Floc™ is to be located near the injection system (Phase 4). Bulk containers require secondary containment to prevent the release of leaks and spills to the ground. The system should not be allowed to freeze, and engineering precautions should be employed to prevent this (e.g., heat blankets or equivalent). The production date is marked on each bulk storage container, and each should be used in the order of their relative production dates and in a timely manner.

5. **StormKlear™ Liqui-Floc™ Injection System:** A high viscosity metering pump is used to pump StormKlear™ Liqui-Floc™ from the bulk storage container to the influent line prior to the sand filters. The injection point should be located in an operations shed. The pump(s) should have the ability to pump 10gph at 80psi. The pump should be calibrated to inject at a pre-determined dose rate based upon the flow and influent water characteristics. This requires regular calibration during operations and maintenance activities. Polypropylene tubing may be used to connect the chemical metering pump to the injection point and must be protected in order to prevent abrasion or puncture as significant vibration can occur. This system will have a second StormKlear™ Liqui-Floc™ metering pump for pre-dose applications.

6. **Conveyance Lines:** Conveyance piping between the influent pump, the rest of the system components, and the discharge point can be flex or Schedule40 PVC piping rated for the pressure of the system and sized for the expected flow rate. Hydraulic calculations based on friction, head pressure, and desired flow rates should be made and considered for the final system design. Typically, 4" piping is standard for flow rates up to 350 gpm, 6" for 350-750 gpm, and 8" for 750 gpm and above. Pretreatment will be performed in the pretreatment line using a second StormKlear™ Liqui-Floc™ Injection System. Flow directional control valves for recirculation / discharge are used to direct flow through the system and can be manual or automated ("Recirculation" refers to any water passing through the system that is diverted back to the source; "discharge" is any water passing through the system and released to the final outfall). The system will be set in automated position and the readings for the effluent pH and turbidity readings are used to direct any water that is out of pre-set values back to the source preventing discharge violations.

7. **Sand Filtration Unit:** Size and capacity of pressure sand filters will depend on desired flow rate. Filtration media wil include ¾" to ⅝" triple-washed crushed rock for the base and #30 silica sand (or equivalent) (see sandfilter specifications manual for fill quantities). The sandfilter is designed to a flow rate not to exceed 15gpm per square foot of sand filtration bed.

8. **Backwash Return:** The backwash line discharge should not be more than 50 feet from the filters for best performance, and the outfall must be at or below the sand filter discharge elevation. Backwash will be returned to the initial influent tanks. Five to ten percent of the detention capacity should be reserved in order to accommodate backwash volumes and retain suitable freeboard in the detention structure.

9. **Effluent Flow Totalizer:** An effluent flow totalizer must be used at each effluent discharge point to determine discharge volumes and totals for recording and reporting purposes.

10. **Effluent Outfall:** The location where the treated stormwater enters the receiving water body.

3 System Operation

Personnel operating the water treatment system should be properly trained and all activities should be properly documented. A journal or bound notebook for dated/time entries is recommended. Any questions regarding the normal startup or operation of the system should be immediately directed to the Tri State project manager (or as directed). The following procedures should be conducted (generally in order) for proper system commissioning. Complete Operations Log (Appendix B) and inform the Tri-State project manager of any and all necessary repairs to complete prior to system start up. Many pieces of equipment included in the overall system have technical manuals beyond the scope of this document and should be referenced for detailed operating and troubleshooting information.

Weekly reports will be submitted to Tri State and the designated WSDOT representative for the preceding week at the project site meeting or by email. Per permit conditions, if there is an upset, WSDOT will be immediately notified by either Tri-State or Water Tectonics depending on the operating team in charge. WSDOT must then notify Ecology immediately of upset conditions.

3.1 Visual Inspection Upon Start-Up

1. Visually inspect hydraulic fittings for damage or leakage making notes if any are observed.
2. Visually inspect the service-entrance-disconnect on the exterior of the operations shed for damage.
3. Visually observe all exterior (influent/effluent) piping for damage or leakage.
4. Visually inspect control panels for dents, scratches, or other damage.
5. Visually inspect the StormKlear™ Liqui-Floc™ bulk storage container for damage. If damage or leakage is observed, photograph the leakage, place an acid absorbent pad under the area of the leak, and notify the project manager immediately.
6. Visually inspect the water quality meters or controllers (pH and turbidity).
7. Visually inspect metering pump(s) and connections for leaks.
8. Ensure that all electric power cords are plugged in as necessary.
9. Visually inspect all tanks for signs of free floating hydrocarbon.
10. Visually inspect that the carbon dioxide tanks are not leaking or empty.
11. Visually inspect the area around the treatment site for any changes in water conditions or odors (such as sulfide, volatile organic compounds-VOCs, or hydraulic oils) derived from influent water.

   *If needed, items listed above will be either repaired or replaced as it becomes necessary.

3.2 Operations Procedures

1. Open all influent and effluent isolation valves (recirculation/discharge). Be certain that valves are manually in the open position to re-circulate water back to Tanks #1 and #2 during startup.
2. Turn on main power to the exterior of the operations shed.
3. Calibrate all monitoring probes or meters according to manufacturer's specifications.
4. Turn on influent pump(s) and adjust valve to desired flow rate (noted on influent flow meter). System may require a significant amount of time to fill pipes, valves, and sandfilter pods before accurate flow rates are assured.
5. Check influent and effluent pressure gages for carbon dioxide and compressed air to ensure that a minimum of 8psi is present as the differential.
6. Set sand filter to desired backwash intervals. This will be based on influent turbidity and loading of the sandfilter bed. Set pressure differential to a maximum of 10-15 psi. This will allow the sandfilter to automatically backwash at a pre-set psi differential. This will compensate if the backwash time interval is sufficient to clean the filter beds. Refer to the sandfilter manufacturer manual for details.
7. Calibrate StormKlear™ Liquifloc™ injection pump(s) using calibration tube to ensure that the proper dose is being delivered based on flow rates.
8. Record influent and effluent pH and turbidity readings.
9. Inspect discharge at outfall (in this case recirculation outfall) and measure pH and turbidity levels manually using grab sample. Measure against system probe readings to ensure accuracy.
10. Visually inspect StormKlear™ Liqui-Floc™ injection hoses to ensure proper injection.
11. Ensure effluent and recirculation water is within permit or specification numerical criteria using field instrumentation calibrated according to manufacturer's specifications using grab samples and cross checking against system probe readings. Make note of any variations outside of specified limits, and do not discharge until acceptable limits are achieved.
12. When all equipment calibration and system operational inspections are complete, return valves to standard positions to allow discharge. Water will be discharged by gravity to sanitary sewer manholes or pumped to a force main.

Note: If the turbidity of influent water is greater than 600 NTU, it may be necessary to perform pretreatment. During pretreatment, water is dosed with Chitosan and allowed to settle in a detention basin or tank. After settling, the water is checked for residual Chitosan, dosed a second time, and passed through the sand filters. The pre-treatment dose rate and the standard (second) dose rate together cannot be more than 1 ppm Chitosan. A variance may be requested from Ecology for a combined dose rate of up to 3 ppm. Permission to use the increased dose rate is largely dependent on the satisfactory implementation and maintenance of traditional erosion and sediment control BMPs.

Return all on-site documentation back to its original location. Complete Operational Checklist (Appendix B), and return a copy to the Tri-State project manager.

3.3 Operations and Maintenance Inspections

Inspections to be performed when the water treatment system is in operation and at a minimum once a week with a report filed with the designated WSDOT representative.

1. Examine fittings, hoses and piping (internally and externally) for leakage or damage making note if observed.
2. Visually inspect the pump's control panel or user interface for any error messages. If error messages exist, make note and take appropriate steps to correct, if any.
3. Visually inspect metering pump and check calibration tube to ensure proper dose is being delivered at start up and every four hours of operation.
4. Open the sand filter control box and manually put the system into backflush mode following manufacturer's instructions. Visually inspect site glass, watching for discharge to run clear (or visibly clearer). Note the amount of time required to achieve this clarity – set backwash duration to meet or exceed this duration (typically 2 to 4 minutes). Backwash valve should be set to approximately three turns open from the closed position to prevent discharge of media. Typical flow rates are as follows: a) three-pod filter, less than 1/3 of flow will be diverted through backwash line during backwash cycle, b) four-pod filter, less than ¼ of flow will be diverted through backwash line during backwash cycle. Once complete, turn the system back to automatic mode and close the control box.
5. Similar inspection of the cartridge filters and carbon filters to be performed.
6. Throughout treatment period (at least every two hours) collect grab samples from effluent, read turbidity and pH, and perform residual Chitosan test to ensure system is operating within specifications following the guidelines listed in *Appendix C, Influent and Effluent Water Sampling Guidelines.* If the system is not operating within specifications, follow troubleshooting guide and/or contact the project manager.

Complete the Operations Log (Appendix B), and return a copy to the project manager. Field technicians performing system inspections should properly document their activities and observations. Questions that the operator encounters during operations and maintenance functions should be directed to the project manager.

At the end of each 8-hour shift, a certified CESF operator must record his/her assessment of the operational status of the CESF process including but not limited to any that apply: bypasses, error messages that affect efficiency, upsets, residual chitosan test results, volume of effluent discharged, volume of StormKlear™ Liqui-Floc™ used and/or other relevant observations affecting the system's operation. The designated trained operator will attest to their understanding that the discharged effluent waters were or were not within specified water-quality standards. Return all on-site documentation back to its original location.

All solid waste collected to be disposed of per local regulations and codes.

4 System Troubleshooting

Potential Causes and Corrective Actions:

1. StormKlear™ Liqui-Floc™ dose rate is not correct
   - Check metering pump for proper operation.
   - Check StormKlear™ Liqui-Floc™ level in bulk storage container, and replace if empty.
   - Check influent turbidity and flow rate. If either has increased, increase dose rate accordingly.

2. Sand filter unit is not functioning properly
   - Check to see that unit is installed correctly.
   - Check to see that adequate filtration media remains in the filter pods.
   - Check to see that the backwash cycle is set properly and is functioning.
   - Check pressure gauges for correct operational psi to allow for proper backflush.

3. Influent turbidity is greater than 600 NTU
   - Determine if pre-treatment is needed. If so, adjust valves so that flow through the system is routed back to the detention pond/tank for settling after StormKlear™ Liqui-Floc™ injection.
   - Check site conditions. Discuss need for increased implementation/maintenance of traditional Best Management Practices (BMPs) with project manager.

4. Influent pH is outside of the 6.5 to 8.5 range
   - Adjust pH to acceptable range prior to StormKlear™ Liqui-Floc™ injection.

5. Site contaminants in detention pond/tank
   - Check to see if soil tackifiers or other binding agents have been used onsite.
   - Check to see if any petroleum products or other materials have spilled onsite.

5 System Contingencies

This enhanced treatment system is designed with continuous monitoring of turbidity and pH. The system will be programmed to switch automatically into a recirculation mode when effluent water quality is outside the permit specified numerical criteria for pH and turbidity. The operator must note water quality parameters and his or her response actions in the log book.

In the event that the system experiences a failure which requires an extended shut-down, several options will need to be evaluated by the project management team, including, but not necessarily limited to:

- Arranging temporary on-site storage of stormwater for clarification at a later time.
- Arranging off-site trucking of water for authorized disposal.
- Arranging a replacement system and/or components of the system for onsite use prior to discharge.
- Add additional treatment steps to the treatment system

The specific course of action will be evaluated and executed on a case-by-case basis. Selection criteria for any specific contingency response may include location, flow rate, water quality parameters, replacement equipment, or budgetary considerations.

Elevated pH or depressed influent stormwater volume may occur from time to time. In the event that stormwater exceeds a pH level of 8.5 standard units (SU), the water will require neutralization prior to the addition of StormKlear™ Liqui-Floc™. Reduction of stormwater pH can be achieved by using liquid carbon dioxide injection. In the rare event that the pH drops below 6.5 SU, caustic (sodium Hydroxide) will be added. The rates at which pH adjustment compounds are added, as well as the cut-off point for adding the product, depend upon the water chemistry, flow rate of the system, and nature of the additives.

WATERTECTONICS

Quick Reference Sheet #1

Field Residual Chitosan Testing

Abbreviated from "Determination of Residual Chitosan in Treated Stormwater using the Iodine – Iodide Polysaccharide Test" Halosource March 2007, found in the StormKlear™ Liqui-Floc™ 1% CESF O&M Manual.

Equipment & Materials:

Containers/Beakers (1000 ml, 500ml, 10 ml)
Glass Fiber filters (25 mm)
Filter holder (25 mm)
Syringe with threaded tip connector
Droppers
Turbidimeter
Sodium Bicarbonate (Baking Soda)
Iodine - 0.1 N solution as I_2
StormKlear 1% Liqui-Floc Chitosan
Distilled or de-ionized water
pH Meter or pH paper/strips

Field Sampling Test:

1. Collect 1 Liter (1000 ml) of effluent after the sand filters (site outfall)
2. Test with a turbidimeter to ensure the turbidity is less than 10 NTU.
3. Adjust the pH of the first sample to > 8 with baking soda (add approx. 1 teaspoon, mix for 1 minute).
4. Confirm pH with pH meter strips add more baking soda if needed and mix.
5. Filter 200 mL of the sample through the 25 mm glass fiber filter unit using the syringe to push water through filter unit.
6. Air-dry the 25mm glass fiber filter. The glass filter should be nearly dry or completely dry to obtain the best results.
7. Put one drop of 0.1N Iodine on the dried filter paper, wait 15 minutes then interpret the results.
8. A light yellow-rust color indicates the absence of chitosan (<0.2 mg/L). A dark brown or blue/black color indicates the presence of chitosan (>0.2 mg/L).
9. Record results on operations form (no chitosan = negative test result)

QA/QC:

Field Matrix Spike: This test creates positive result to ensure that the test works appropriately as performed by the specified personnel with the equipment and reagents on hand.

Perform a field matrix spike by adding 20µl of StormKlear 1% Liqui-Floc to a second 1 liter effluent sample. This solution now has at least 0.2 mg/L chitosan acetate. Proceed with steps 2 thru 9 above. The filter paper should have a brown to blue/black color after the addition of Iodine

Field Method Blank: This test detects contamination of the test equipment. The result of the method blank should always be negative. A positive result indicates Chitosan contamination which could skew future field testing results.

Perform a field method blank by using 1 L of de-ionized or distilled water in place of the effluent sample. Proceed with steps 2 thru 9 above.

NOTE: Field sampling must occur within 30 minutes of system start-up and at minimum once per shift when treating. QA/QC testing should be performed at regular intervals.

Quick Reference Sheet #2

Bench (Jar) Test to Determine Dose-Rate

Modified from the StormKlear™ Liqui-Floc™ 1% CESF O&M Manual.

Equipment & Materials:

4 - 1L clear, clean glass containers
Dropper (0.5 mL/drop)
Stir Rod
25 mL StormKlear™ Liqui-Floc™ 1%
Distilled or de-ionized water
pH meter or pH paper/strips
Turbidimeter (calibrated per operator specifications)

Method:

1. Collect four 1 liter samples of stormwater from detention pond (source water); label C, D1, D2, and D3. The beaker C will be the control.
2. Read pH and turbidity - pH must be between 6.5 and 8.5 and turbidity <600 NTU*
3. Add one drop of StormKlear™ Liqui-Floc™ 1% in D1 (0.5 ppm), 2 drops in D2 (1.0 ppm), and 3 drops in D3 (1.5 ppm). Each drop represents approximately 0.5 ppm chitosan.
4. Stir the jars vigorously for approximately 30 seconds. Allow to stand for 5 minutes.
5. Compare the D samples to the control (C). Treated beakers should begin to flocculate which appears as a grainy or curdled look and the water column should start to become clear.
6. Use the lowest effective dose rate (flocculation was observed). The maximum dose rate is 1ppm unless a variance has been approved by Ecology.
7. Record results on the operations log.

*If influent turbidity is greater than 600 ntu, run bench test as detailed above. The results will give the pretreatment dose rate. Once the pretreated water has settled perform another bench test with the pretreated water to determine the final dose rate. The pretreatment and final dose rates combined cannot exceed 1ppm Chitosan without prior Ecology approval. A variance may be requested from Ecology for a combined dose rate of up to 3 ppm. Permission to use the increased dose rate is largely dependant on the satisfactory implementation and maintenance of traditional erosion and sediment control BMPs.

Applying dose rate in ppm to CESF treatment system:

1. Determine flow rate of system (flow meter reading)
2. Using the Dose-Rate Chart correlate flow (gpm) to the dose rate (ppm) obtained from the Bench test to determine the injection pump rate (ml/min or gph).
3. Using the calibration tube, set the injection pump to the correct injection rate (ml/min or gph)

1% StormKlear™ LiquiFloc™ Injection Rate Table

Stormwater Flow Rate	Chitosan Dosage			
	0.25 mg/l (0.25 ppm)	0.5 mg/l (0.5 ppm)	0.75 mg/l (0.75 ppm)	1.0 mg/l (1.0 ppm)
100 gpm	9.4 ml/min. or 0.15 gph	19 ml/min. or 0.30 gph	28 ml/min. or 0.45 gph	38 ml/min. or 0.60 gph
200 gpm	19 ml/min. or 0.30 gph	38 ml/min. or 0.60 gph	57 ml/min. or 0.90 gph	75 ml/min. or 1.2 gph

Example:
Bench Test Does Rate = 0.5ppm
Flow rate = 200 gpm
so…
Injection Rate = 38ml/min
or 0.60 gph

WATERTECTONICS

Quick Reference Sheet #3

1% StormKlear™ LiquiFloc™ Injection Rate Table				
Stormwater Flow Rate	Chitosan Dosage			
	0.25 mg/l (0.25 ppm)	0.5 mg/l (0.5 ppm)	0.75 mg/l (0.75 ppm)	1.0 mg/l (1.0 ppm)
100 gpm	9.4 ml/min. or 0.15 gph	19 ml/min. or 0.30 gph	28 ml/min. or 0.45 gph	38 ml/min. or 0.60 gph
200 gpm	19 ml/min. or 0.30 gph	38 ml/min. or 0.60 gph	57 ml/min. or 0.90 gph	75 ml/min. or 1.2 gph
300 gpm	28 ml/min. or 0.45 gph	57 ml/min. or 0.90 gph	85 ml/min. or 1.3 gph	110 ml/min. or 1.8 gph
400 gpm	38 ml/min. or 0.60 gph	75 ml/min. or 1.2 gph	110 ml/min. or 1.8 gph	150 ml/min. or 2.4 gph
500 gpm	47 ml/min. or 0.75 gph	94 ml/min. or 1.5 gph	140 ml/min. or 2.2 gph	190 ml/min. or 3.0 gph
600 gpm	57 ml/min. or 0.90 gph	110 ml/min. or 1.8 gph	170 ml/min. or 2.7 gph	230 ml/min. or 3.6 gph
700 gpm	66 ml/min. or 1.0 gph	130 ml/min. or 2.1 gph	200 ml/min. or 3.1 gph	260 ml/min. or 4.2 gph
800 gpm	75 ml/min. or 1.2 gph	150 ml/min. or 2.4 gph	230 ml/min. or 3.6 gph	300 ml/min. or 4.8 gph
900 gpm	85 ml/min. or 1.3 gph	170 ml/min. or 2.7 gph	250 ml/min. or 4.0 gph	340 ml/min. or 5.4 gph
1,000 gpm	94 ml/min. or 1.5 gph	190 ml/min. or 3.0 gph	280 ml/min. or 4.5 gph	380 ml/min. or 6.0 gph

Notes:

0.25 mg/l dose rate is appropriate for turbidity up to 250 NTU.
0.50 mg/l dose rate is appropriate for turbidity up to 500 NTU.
0.75 mg/l dose rate is appropriate for turbidity up to 750 NTU.
1.0 mg/l dose rate is appropriate for turbidity up to 1000 NTU
Calculations based upon laboratory-confirmed specific gravity of 1.003 g/mL
All values presented as two significant figures

Directions for use:

1. Determine the sand filtration system target flow rate (left-hand column).
2. Determine, based on turbidity measurements, the target dose rate (top row).
3. Determine the rate of StormKlear™ Liqui-Floc™ injection in milliliters per minute (ml/min) or gallons per hour (gph).
4. Using the injection pump manufacturer's instruction, measure and adjust the StormKlear™ Liqui-Floc™ dosage rate to equal the target injection rate as appropriate.
5. Verify actual chitosan flow rate by reading the injection calibration tube and adjust the injection rate, if necessary. Document any changes required.
6. If turbidity fluctuates, adjust injection rate as necessary.

WATERTECTONICS

Quick Reference Sheet #4

CESF System Operation

System Start-up:

1. Set valving to re-circulate effluent to detention/source during startup.
2. Turn on main power to the exterior of the operations shed.
3. Turn on influent pump(s) and adjust valve to desired flow rate (check flow meter).

   NOTE: System may require a significant amount of time to fill pipes, valves and sand filter pods before accurate flow rates are assured.
4. Set sand filter to desired backwash intervals (time) and leave the pressure differential switch “on” set to a maximum of 10-15 psi. This will allow the sand filter to automatically backwash at pre-set psi differential should backwash set time intervals not be sufficient to clean the filter beds.

   NOTE: Check the glass site in the back wash line to ensure that the filter media flushed out during backwash. Refer to sand filter manufacturer manual for details.
5. Calibrate chitosan injection pump(s) using calibration tube to ensure the injection pumps are set to the proper injection rate to deliver the proper dose based on flow rate.

   NOTE: Total dose rate (pre-treatment plus final) cannot exceed 1.0 ppm chitosan acetate by weight or 100 mg/L as 1% StormKlear Liquifloc
6. Visually inspect StormKlear™ Liqui-Floc™ injection hoses to ensure proper injection.
7. Observe in-line WQ readings & verify with grab sample collected at source (influent) and re-circulation outfall (effluent). Calibrate in-line probes if needed.
8. When all equipment calibration and effluent water quality is verified, return valves to standard positions and discharge to the site outfall.
9. Record time discharge started, influent and effluent readings (flow, ntu, pH), sand filter settings, chitosan level in drum/tote, chitosan injection rate, and any calibration that occurred.
10. Perform field residual chitosan test within 30 min of system start-up.

System Operation

1. Routinely check plumbing, metering pump, calibration tube and sand filters.
2. Routinely (at least every two hours) collect grab samples from effluent, read turbidity pH, compare to inline readings, record.
3. Visually inspect the pump’s control panel or user interface for any error messages. If error messages exist, make note and take appropriate steps to correct, if any.
4. Record the following during the treatment cycle (if/when they occur):
   - Recycle event – note time, corrective actions taken, duration and volume recycled
   - Sand filter backwash – time(s) & duration, if excessive corrective actions taken

System Shut-Down

1. Turn off Chitosan injection pump.
2. Turn off pumps – influent and sand filter pump (if equipped).
3. Record (time system was shut-off, totalizer readings (influent/effluent), volume of chitosan consumed.

Appendix C- Operations Data Sheets

CHITOSAN ENHANCED SAND FILTRATION SYSTEM OPERATIONS LOG

Site		**Operator**		**Date**	
Chitosan Tote ID		Start Time		End Time	
Tote Quantity	Full ¾ ½ ¼	Flow Totalizer	Initial:		
			Final:		
Pre-treat. Dose Rate	gph ml/min = ppm	Flow Rate (gpm)	Note changes in comments below		
Standard Dose Rate	gph ml/min = ppm	Volume Discharged (gal)			
Total Dose Rate (ppm) Pre + Standard rates	ppm	Sandfilter Backwash Cycle Setting	Timing:		
			Pres. Diff.		

Water Quality/Performance Monitoring

Time	Sample	Location	Turb (ntu)	pH	Residual Chitosan Results	Comments
	Grab / On-line				+ / -	
	Grab / On-line				+ / -	
	Grab / On-line				+ / -	
	Grab / On-line				+ / -	
	Grab / On-line				+ / -	
	Grab / On-line				+ / -	
	Grab / On-line				+ / -	
	Grab / On-line				+ / -	
	Grab / On-line				+ / -	
	Grab / On-line				+ / -	
	Grab / On-line				+ / -	
	Grab / On-line				+ / -	

Online meters performing correctly vs. grab samples?	Y N	If no, corrective action taken:

Comments:

Technician Signature

Appendix D- Troubleshooting Responsibility Matrix

Jorgenson Project Responsibility Matrixs

ystem LeadS5 *Jeff Mitchella5*
425-248-0185a

Project LeadS5 *Pete Johnson5*
425-275-13815

EXAMPLE ONLY AT THIS TIME

Contract AdministratorS5 *Liisa Doty5*
206-371-16935

esponsibilities	**WTs**	**Ms**	**Rain For Rents**
Daily Operations of Treatment System		X	
Troubleshooting of WT Rental Equipment	X	X	
Troubleshooting of RFR Rental Equipmentfi	X		X
Maitenance / Repair of WT System	X		
Maitenance / Repair of RFR Systemfi			X
Monitoring Consumable Levels		X	
Consumable Replacementfi	X		
Daily Record Keepingfi		X	
Maitenance/Repair Logs	X		
Generator Fueling / Servicingfi		X	
Analytical Samplingfi		X	

Weekly Maitenance and Performance Checks s

Water Tectonics will perform two regularly scheduled weekly maitenance visits per week during times of system fi operations

Service / Repair / Troubleshooting Requests

In the event that any service, repair, or troublehooting visit is required outside weekly maitenance visits, Water fi Tectonics will be available on an "as needed" or "on call basis". It is the responsibility of Envirocon to provide fi notification to Water Tectonics when the visits are necessary.fi

esponse Times

prioritys	**Examples**	**hone Responses**	**esponse To Sites**
Critical	Emergency, system is in-fi operable and causing up-fi stream project delays	Business Hrs: 1 Hr Off fi Business Hrs: 2 Hrs fi	Business Hrs: 2 Hrs Off Business Hrs: 6 Hrs
Urgent	System in-operable but is not fi causing up-stream project fi delays	Business Hrs: 2 Hrs Off Business Hrs: 4 Hrs	Business Hrs: 6 Hrs Off Business Hrs: 24 Hrs
Routine	System enhancement, fi planned changes, general fi questions	Business Hrs: 4 Hrs Off Business Hrs: Next Business Day	Within two business days

Water Tectonics Contact Lists

Please make Water Tectonics onsite service requests to the following peoplefi

Names	**Telephone Numbers**
1. Jeff Mitchellfi	425-248-0185fi
2. Pete Johnson	425-275-1381
3. Eric Hanson	206-571-1727fi
4. Scott Beaudoin	425-563-3608fi